making it more valuable to the entire vehicle.

The Bradley is further hampered by not having a coaxial or hatch-mounted machinegun. Today, if the vehicle experiences turret power failure or battle damage, it requires an extreme effort on the gunner's part to traverse and elevate the weapons to defend against close attack by dismounted infantry, aircraft, or vehicles.

The solution to this problem is to slightly modify the vision block guards around the Bradley commander's hatch to accommodate the mounting of an M60D machinegun. This would allow the gun to traverse about a 90-degree arc left and right while the pintle would give the machinegun an almost unlimited ability to depress and elevate. A Bradley commander would immediately be able to protect his vehicle from attack.

Serious consideration should also be given to what the Bradley's driver, gunner, and commander have as personal weapons. Under the current TOE (tables of organization and equipment), they are issued M16A2 rifles and no side arms. They are stored in hard-to-reach places in the vehicle and certainly cannot be passed through a hatch that has someone standing in it. This means they cannot be used quickly. Simply put, the Bradley crew members need to be able to fight for their vehicle much the same way artillerymen have historically fought for their guns.

On the next point, it appears that armor soldiers agree with me that the crews of both the M1A1 tank and the Bradley need side arms and submachineguns for the security of their vehicles. The M9 pistol is replacing the M1911A1 as the standard side arm for both the infantry and the armor, but the tankers are replacing the M3 submachinegun with a shortened variant of the M16A2. Tankers have used the M3 since World War II, and it has proved itself when an enemy climbed on a tank, for example. It was smaller than either the M1 Garand or the M1 carbine and used the same ammunition as the M1911A1. The infantry has no such weapon for its vehicle crews, and even the tankers now need a different one.

The replacement weapon should use the same ammunition as the M9 and be small enough to handle easily, and, should the need arise, to be stuck through an open hatch and fired.

The solution, again, is readily available. I believe that several weapons in use by police around the world meet those criteria now. The Army could easily acquire MP5s, Uzis, or rechambered MAC-11s in the required numbers. These types of weapons are compact, light, and capable. They have high rates of fire and could easily suppress an enemy at 150 meters. Shoulder holsters are available on the civilian market that would allow both tank and Bradley crews to carry those weapons while performing their missions in the vehicle.

It's time for the Army to start acquiring the "off-the-shelf" items that make sense and that will help us now. If an item is available today that will save lives and accomplish the mission, then we need it today. The common infantryman on the ground does not want to wait for the Army to develop a weapon that will carry him into the next century when the lack of such a weapon tomorrow may cost him his life. Let's not pay the price for learning a hard lesson.

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Land Navigation

SERGEANT FIRST CLASS STUART M. JOHNSTON

In INFANTRY's November-December 1990 issue, Major Charles F. Coffin discussed the merits of the protractor compass. (See "The Protractor Compass," pages 15-17.) I would like to take this discussion a few stages further, because there are various aspects of land navigation that I believe are lacking in our current training.

To start with the basics, we seldom teach or even mention tactical navigation to our soldiers, but surely this is what an infantryman must do to reach his objective and accomplish his mission. Infantrymen are not orienteers who want to get to the next point by the quickest, shortest possible route. They want to use the most covered and concealed route to mask their movement to the objective. To do this they must learn to read the ground they will be covering, and they learn to read the ground by conducting map reconnaissances and developing the ability to see this flat piece of paper as a three-dimensional picture. Then, once out on the ground they look for dead ground

that can be used to best advantage.

This may sound rather far-fetched for a young private, but if he is taught from the start to look closely at the contour lines and the contour interval on a map, reading them will soon become second nature to him. He needs to get out to the field as often as possible with map and compass, sit at a known point, and compare a map to the ground. A leader does not need a vast training area to allow all his soldiers to do this.

As part of such a map reconnaissance, an intervisibility study can well be done, depending on the mission. For example, if you plan to site an observation post (OP) from which to look at a specific point such as a road intersection, you may find when you get there that a hill is obstructing your view. A simple graph will tell you this before you leave your planning area.

The first thing to do is to mark your potential OP (point A) and the place you want to observe (point B) on your map. Next, put the edge of a blank sheet of paper running through these two points. Mark on the paper points A and B and all the contour lines in between them. Write next to these marks the elevation of each contour line, including the elevations of A and B. Now take the paper away from the map and draw lines straight down from the marks. Draw a graph below these with the contour values marked down the left side. Continue the lines into the graph, stopping each one at its appropriate value. Mark the end of each line with a small X. Once all the lines have been marked, join the Xs. The resulting line will be the same shape as the actual ground between points A and B. (See Figures 1 and 2.)

It should be noted that, because of the curvature of the earth, this method is accurate only for distances up to three kilometers. (There is a formula that allows for this curvature, but it is quite complex.) Also remember that if there is a hill between points A and B, it could have trees or buildings on it that would effectively add several meters to its height and thus obstruct the view. (Figure 1 shows intervisibility and Figure 2 non-intervisibility.)

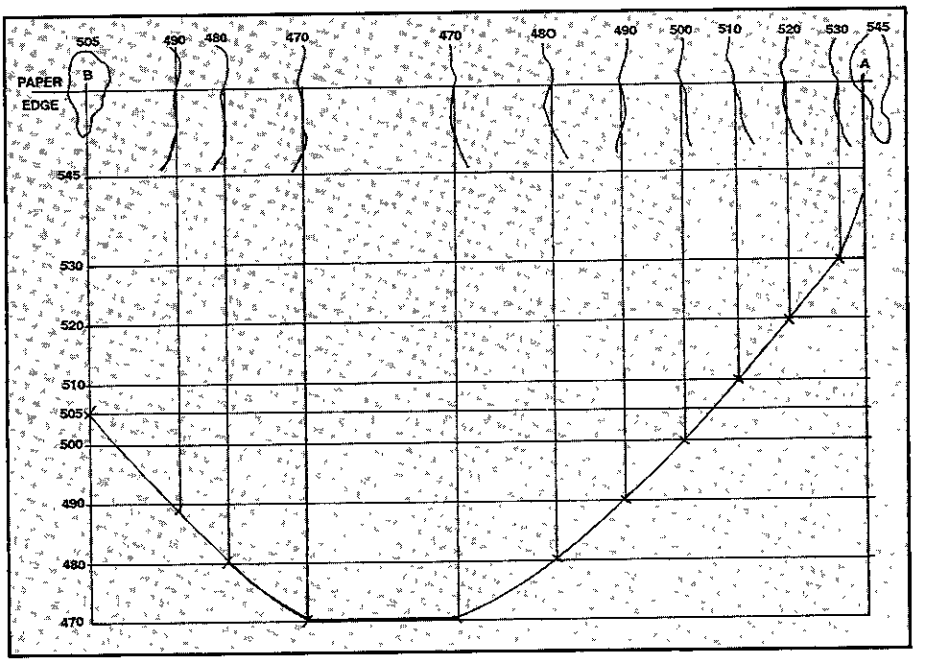

Figure 1

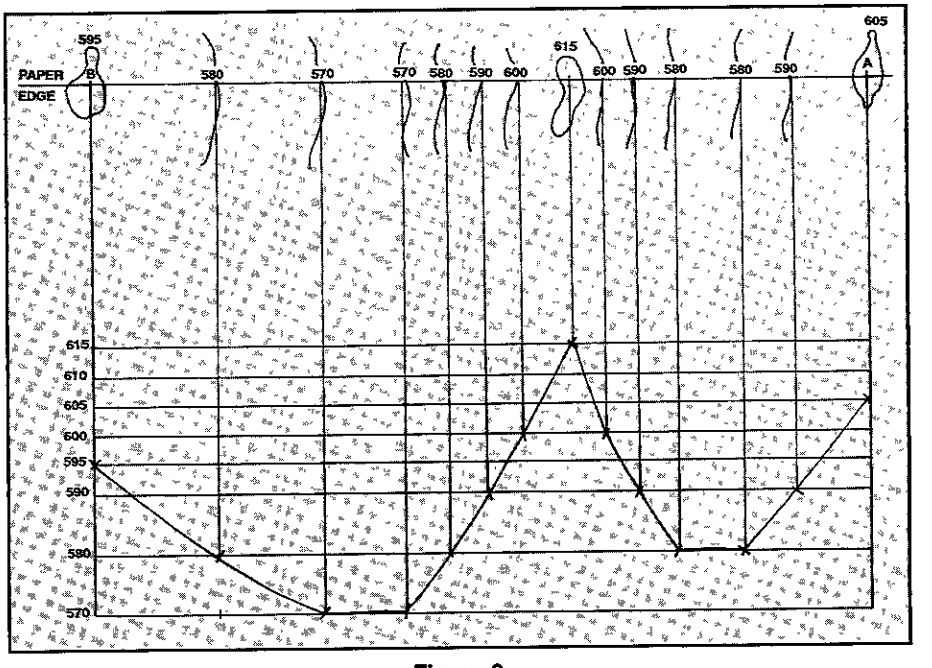

Figure 2

Intervisibility studies are also useful in defensive positions, because they can quickly identify any dead ground in which the enemy could hide. From your defensive position, do as many intervisibility graphs as time allows for the likely enemy approaches. From these, you will be able to see where all the dead ground lies. (Radio operators can also use this system to find out whether they have line of sight for their radios.)

Along with the map reconnaissance, leaders must consider likely positions for enemy OPs and the capabilities of the enemy's surveillance equipment, such as thermal imagers and image intensifiers. Infantrymen can no longer move freely around the battlefield at night, and route selection has become more and more critical.

Unfortunately, our land navigation courses, set up as they are, develop skills in the soldiers that are totally opposite of those they need. There is always a

rush to get them from point A to point B. They put an azimuth on their compasses, and go off with little or no thought to the ground they will have to cover. The ability to differentiate among six poles, spaced 200 meters apart along a road, bears little relevance to any tactical problem I have ever come across, with the possible exception of a passage of lines. Yet this is a common task in battalion land navigation training and at the various schools infantrymen attend.

Something else that would help teach navigation would be for everyone to use mils instead of degrees. Currently, infantrymen, with the exception of mortarmen, use degrees for everything. Other combat arms soldiers use mils.

If we all used mils, we would not have the problem of converting from one system to the other. When an infantryman passes an azimuth in degrees to his fire direction center (FDC), it has to be converted to mils for use by the gunline. This may sound simple enough, but it is one more place where an error may occur, and it wastes valuable seconds that might save a soldier's life. (Also, in these days of multi-national armies, we would be using the same system as our allies in NATO.)

In addition to standardization, mils are far more accurate than degrees. With mils, a circle is divided into 6400 increments as opposed to 360 using degrees, and directions can be far more precise. Our current lensatic compass is marked in mils, and it would be a simple matter of getting people in the habit of using mils. If we should change over to a protractor compass in the future, models using mils are also readily available.

Another excellent navigational tool I would like to mention is the altimeter. Altimeters are now available on many moderately priced wrist watches. (See "The Altimeter," by Lieutenant Colonel William Menning, INFANTRY, November-December 1990, pages 40-42.)

Finally, aerial photography is a much neglected navigational aid that deserves better recognition. Aerial photographs are the next best thing to actually looking at the ground. An aerial photograph will show, for example, whether there are obstructions that limit intervisibility, even if they do not appear on the map. These photos also provide the most up-to-date information available on enemy positions, new roads, cut-down trees, and the like.

Basically, aerial photographs come in two types—oblique and vertical. The oblique type—taken from the front, side, or rear of an aircraft—provides a view of the ground that is much like the one you would see if you were standing on high ground and looking out over your planned patrol route. This type of photo still has dead ground and

is not very useful to an infantryman. The other type, the vertical—taken from directly above—provides a picture much like a map, and this is the one infantrymen should be most interested in.

It is not always easy to identify the area a photograph covers, because it does not come with grid coordinates marked on it (although it does show the date time group when it was taken). The best thing to do is to find an easily distinguishable shape on the photograph—such as a lake, forest, or road intersection—and then look for it on the map. Once this is done, find two easily identifiable points on the map that are directly under one easting line; then find these two points on the photograph and draw a line connecting them. This becomes your north arrow.

Your next task is to scale the photograph, and this is also quite easy. Again, look for two points on the map, but this time not necessarily under an easting. Find their exact distance apart by using the map scale. (The points should be 1,000 meters apart, although this is not vital.) Once you have done this, find these same two points on the photograph. The distance between the two points is the same as the ground distance between the two points on the map. Transfer this measurement to the edge of the photograph and divide it into ten equal segments, and you have your scale. Remember, though, that three centimeters on one photograph is not the same ground distance as three centimeters on another photograph, because they may have been taken from different altitudes.

Unfortunately, aerial photographs distort around the edges because of the camera lens, so putting a grid on a photograph is very complicated and not practical for anyone other than an expert.

In an infantry battalion, the S-2 staff members are responsible for obtaining aerial photographs, and they can tell you what paperwork you need. If you tell them the area you want covered, they should be able to do the rest.

This is far from a definitive account of aerial photographs, but a little study will increase your proficiency in using them. (See also "Aerial Photography," by Captain Eugene J. Palka, INFANTRY, May-June 1987, pages 12-14; and "Aerial Photographs," by Sergeant First Class John E. Foley, INFANTRY, March-April 1989, pages 38-39.)

Land navigation is a massive subject, but these suggestions may spark interest in some different skills that can be taught to promote greater efficiency in professional soldiers.

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